FEMP

Federal Energy Management Program

FEMP Designated Product:

Electric Motors

Leading by example, saving energy and taxpayer dollars in federal facilities

Purchasing Specifications for Energy-Efficient Products

Legal Authorities

Federal agencies are required by the Energy Policy Act of 2005 (P.L. 109-58) and Federal Acquisition Regulations (FAR) Subpart 23.2 to specify and buy ENERGY STAR®-qualified products or, in categories with no ENERGY STAR label, FEMP-designated products which are among the highest 25 percent of equivalent products for energy efficiency.

Performance Requirement for Federal Purchases

Motor Size (HP)	Open Drip-Proof (ODP)			Totally Enclosed Fan-Cooled (TEFC)		
	6-pole (1200 rpm)	4-pole (1800 rpm)	2-pole (3600 rpm)	6-pole (1200 rpm)	4-pole (1800 rpm)	2-pole (3600 rpm)
Nominal Efficiencies for Induction Motors Rated 600 Volts or Less (Random Wound)						
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	91.7	93.0	90.2	91.7	92.4	91.0
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4
50	94.1	94.5	93.0	94.1	94.5	93.0
60	94.5	95.0	93.6	94.5	95.0	93.6
75	94.5	95.0	93.6	94.5	95.4	93.6
100	95.0	95.4	93.6	95.0	95.4	94.1
125	95.0	95.4	94.1	95.0	95.4	95.0
150	95.4	95.8	94.1	95.8	95.8	95.0
200	95.4	95.8	95.0	95.8	96.2	95.4
250	95.4	95.8	95.0	95.8	96.2	95.8
300	95.4	95.8	95.4	95.8	96.2	95.8
350	95.4	95.8	95.4	95.8	96.2	95.8
400	95.8	95.8	95.8	95.8	96.2	95.8
450	96.2	96.2	95.8	95.8	96.2	95.8
500	96.2	96.2	95.8	95.8	96.2	95.8
Nominal Efficiencies for Induction Motors Rated Medium Voltage - 5 kV or less (Form Wound)						
250 - 500	95.0	95.0	94.5	95.0	95.0	95.0

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Buying Premium Efficiency Electric Motors

When buying an electric motor, specify or select a model with an efficiency that meets or exceeds those shown in the *Performance Requirement* table. Motor efficiency is identified on the nameplate by "nominal" efficiency, which represents the average efficiency of a large population of motors of the same design. It is measured in accordance with NEMA MG 1-1998, *Motors and Generators*, and IEEE 112 Test Method B.

This *Specification* is for general-purpose, single-speed, polyphase induction motors. Some applications require definite-purpose, special-purpose, special frame, or special mounted polyphase induction motors. A motor meeting the efficiency levels of this *Specification* is usually available for these applications also.

Motors that meet the required efficiency levels carry the NEMA Premium™ label, a program sponsored by the National Electrical Manufacturers Association (NEMA) and endorsed by the Consortium for Energy Efficiency (CEE) (see *For More Information*). The *MotorMaster+* data base lists motors by manufacturer and model number, grouped by size (HP) and type (see *For More Information*). Within each group, the highest efficiency motors are listed first. All models shown above the line labeled "Premium Efficiency - NEMA Table 12-12" meet the requirements of this *Specification*. In many cases, purchasing even higher-efficiency motors can be cost-effective at average federal electricity prices. Cost-effectiveness will increase where there are higher electricity prices or peak demand charges. Buyers should note that motors labeled "energy efficient" will not meet these performance requirements and that only "Premium Efficiency" motors achieve the levels specified.

Agencies must use ENERGY STAR-qualified and FEMP-designated performance requirements for all procurements of energy-consuming products and systems including guide and project specifications, and construction, renovation and service contracts. They should also be used in evaluating responses to solicitations. In contracts and solicitations, agencies must specify that electric motors meet or exceed the nominal efficiencies shown in the *Performance Requirement* table.

Agencies can claim an exception to these requirements through a written finding that no ENERGY STAR-qualified or FEMP-designated product is available to meet the functional requirements, or that no such product is life-cycle cost-effective for the specific application.

Motor Sizing, Replacement, and Speed

Oversized, under-loaded motors should be replaced with smaller Premium energy-efficient motors. A motor with a higher horsepower rating than is required by the load operates at part load. Motor efficiency and power factor decline below 50% of full load, increasing utility power factor charges.

Premium energy-efficient motors usually have higher inrush current than equivalent standard efficiency models. In older buildings, make sure existing motors circuits and protection equipment are adequate to handle this higher initial current, especially when replacing "design B" with "design A" motors.

Look for a Premium energy-efficient replacement motor with a speed closely matched to the speed of the existing motor. Induction motors have an operating speed that is slightly lower than their theoretical, or "synchronous" speed. For example, a typical 1800 rpm motor will operate under full load at about 1750 rpm. Efficient motors tend to operate at a slightly higher full-load speed than standard motors (usually by about 5-10 rpm for 1800 rpm motors). Centrifugal loads, like pumps, fans, and compressors, will be affected by this higher speed with slightly more fluid or air being delivered. In these situations, consider changing pulley sheeves, trimming pump impellers or changing fan cages to match the flow under original circumstances. Depending on the system, higher motor speeds will likely increase energy use and partly offset savings from more efficient motors.

Open Drip Proof vs. Totally Enclosed Fan Cooled

Motors are classified into two groups: open drip proof (ODP) and totally enclosed fan cooled (TEFC). These classifications are based on the method used to cool the motor. An open drip proof motor has interior components that are cooled by a fan moving cool air through intake and exhaust vents. A totally enclosed fan cooled motor has an externally-mounted fan that blows air across the motor casing. When in operation, a TEFC motor's interior components dissipate heat to a heat sink, which is the motor's casing. The casing is then cooled by the externally-mounted fan. ODP motors can have higher maintenance costs due to the exposure of interior components to dirt and other contaminants. Because TEFC motors are designed for use in harsher environments, their first costs are typically higher than ODP motors.

Variable Frequency Drives

Variable frequency drives (VFDs), the most common type of adjustable speed drives, can be used with motors to help lower energy costs. VFDs are electronic systems used to control motor speed by changing the frequency and voltage supplied to the motor. VFDs can result in substantial energy savings, especially for varying loads. Small reductions in speed also can yield substantial energy savings. For example, a 20% reduction in fan speed can reduce energy consumption by nearly 50%. Pump, fan, and compressor systems with variable loads should be considered for retrofit with VFDs.

Rewinding or Replacing Motors

Many users choose to rewind or repair motors when they fail, a practice that is more common with motors greater than 50 horsepower. Even though rewinding a motor costs less than buying a new one, for most applications with high annual hours of operation it is cost-effective to replace a standard motor with a new Premium one. In many cases, it may be cost-effective to replace a standard motor even prior to failure with a NEMA Premium motor.

The Motor Decisions Matter[SM] web site provides guidance on motor replacement and rewinding (see *For More Information*). Once a Premium efficiency motor has been purchased, rewinding or repairing it, even at a quality service center, may degrade its efficiency slightly (0.5% to 1.0% per rewind is the common rule of thumb). Though it is generally not cost-effective to rewind ODP motors, rewinding is often a cost-effective option for large (e.g., greater than 100 HP) TEFC motors. The Electrical Apparatus Service Association (EASA) provides a list of motor service centers (see *For More Information*).

Motor Cost-Effectiveness Example
50 Horsepower, Open Drip Proof (ODP), 4-pole (1800 rpm)

Performance	Base Model	Required Level	Best Available
Full-Load Efficiency	93.0%	94.5%	95.0%
Annual Energy Use	160,430 kWh	157,880 kWh	157,050 kWh
Annual Energy Cost	$9,630	$9,470	$9,420
Lifetime Energy Cost	$123,840	$121,780	$121,140
Lifetime Energy Cost Savings	-	$2,060	$2,700

Cost-Effectiveness Assumptions

The cost-effectiveness example assumes electricity prices of 6¢/kWh, the federal average electricity price in the U.S. Annual Energy Use is based on 4,000 equivalent full-load hours per year. Lifetime Energy Cost is the sum of the discounted value of annual energy costs, based on average usage and on assumed motor life of 18 years. Future electricity price trends and a discount rate of 3.0% are based on federal guidelines effective April 2004 through March 2005.

Using the Cost-Effectiveness Table

In the example above, a 50-hp motor at the required 94.5% full-load efficiency is cost-effective if its purchase price is no more than $2,060 above the price of the Base Model. The Best Available model, with an efficiency of 95.0%, is cost-effective if its purchase price is no more than $2,700 above the price of the Base Model.

What If My Electricity Price Or Load Hours Are Different?

DOE's *MotorMaster+* software includes a savings calculator that allows you to estimate savings and cost effectiveness after defining the capacity, hours of operation, and electricity cost for your motor installation. See *For More Information* to download the *MotorMaster+* software.

For More Information:

EERE Information Center
1-877-EERE-INF or 1-877-337-3463
www.eere.energy.gov/femp/procurement/

DOE's Office of Industrial Technologies provides technical support on motors and co-sponsors with industry the Motor Decisions Matter campaign.
www.motorsmatter.org

DOE sponsors *MotorMaster+*, a selection software package that includes a database of motors and their efficiencies.
(800) 862-2086
www.eere.energy.gov/industry/bestpractices/software.html

National Electrical Manufacturers Association (NEMA) sponsors the NEMA Premium™ label for motors, publishes a list of manufacturers offering premium efficiency motors and standard method for motor efficiency testing and reporting.
(800) 854-7179
www.nema.org/premiummotors/

Consortium for Energy Efficiency (CEE) has utility programs that promote energy-efficient motors.
(617) 589-3949
www.cee1.org

Electrical Apparatus Service Association (EASA) has motor repair guidelines and service centers for motors.
(314) 993-2220
www.easa.com

American Council for an Energy-Efficient Economy (ACEEE) publishes the *Guide to Energy-Efficient Commercial Equipment*, which includes a chapter on motors.
(202) 429-0063
www.aceee.org

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

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